

SHIP PRODUCTION COMMITTEE  
FACILITIES AND ENVIRONMENTAL EFFECTS  
SURFACE PREPARATION AND COATINGS  
DESIGN/PRODUCTION INTEGRATION  
HUMAN RESOURCE INNOVATION  
MARINE INDUSTRY STANDARDS  
WELDING  
INDUSTRIAL ENGINEERING  
EDUCATION AND TRAINING

September 1979  
NSRP 0006

# **THE NATIONAL SHIPBUILDING RESEARCH PROGRAM**

## **Proceedings of the REAPS Technical Symposium**

### **Paper No. 7: The Avondale Pipe Shop: Hardware and Software Status**

U.S. DEPARTMENT OF THE NAVY  
CARDEROCK DIVISION,  
NAVAL SURFACE WARFARE CENTER

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>SEP 1979</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>The National Shipbuilding Research Program Proceedings of the REAPS Technical Symposium Paper No. 7: The Avondale Pipe Shop: Hardware and Software Status</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Naval Surface Warfare Center CD Code 2230 - Design Integration Tools Building 192 Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>SAR</b>	18. NUMBER OF PAGES <b>10</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

## DISCLAIMER

These reports were prepared as an account of government-sponsored work. Neither the United States, nor the United States Navy, nor any person acting on behalf of the United States Navy (A) makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness or usefulness of the information contained in this report/manual, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or (B) assumes any liabilities with respect to the use of or for damages resulting from the use of any information, apparatus, method, or process disclosed in the report. As used in the above, "Persons acting on behalf of the United States Navy" includes any employee, contractor, or subcontractor to the contractor of the United States Navy to the extent that such employee, contractor, or subcontractor to the contractor prepares, handles, or distributes, or provides access to any information pursuant to his employment or contract or subcontract to the contractor with the United States Navy. ANY POSSIBLE IMPLIED WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR PURPOSE ARE SPECIFICALLY DISCLAIMED.



**R** RESEARCH  
**E** AND  
**A** ENGINEERING  
**P** FOR  
**S** AUTOMATION  
 AND  
 PRODUCTIVITY  
 IN  
 SHIPBUILDING

Proceedings of the  
**REAPS Technical Symposium**  
 September 11-13, 1979  
 San Diego, California

**THE AVONDALE PIPE SHOP: HARDWARE AND SOFTWARE STATUS**

**Harris F. Arnold  
Vice-President, Data Processing  
Avondale Shipyards Incorporated  
New Orleans, Louisiana**

**Mr. Arnold is Vice-President in charge of Data Processing activities at Avondale Shipyards, Inc. He has 35 years experience with machine accounting, tabulation, and data processing.**

## **The Avondale Pipe Shop - Hardware Status**

**H. F. Arnold, Vice President -  
Data Processing Avondale Shipyards, Inc.**

Approximately five (5) years ago Avondale Shipyards in cooperation with the Maritime Administration developed a plan for a semi-automatic pipe fabricating facility.

Our study has been conducted at our main pipe shop and utilized manual fitting, welding and burning as a base along with our original ship layout and flow diagram. We originally had a production capacity of 50 - 55 spool pieces per day with a complement of 76 people in this department. Basic changes which we have accomplished during this study, such as wire-feed welding in lieu of stick welding, provision of cutting station, installation of contour cutting machines and utilization of a limited amount of turning and manipulation equipment has increased our production to 60 - 65 spool pieces per day.

During our investigation we made 42 onsite facility surveys. Nineteen foreign facilities and 23 domestic facilities were visited. We conferred with 26 equipment manufacturers and consultants. We maintained technical liaison with 11 foreign and domestic shipyards.

Initially the concept was determined, which established the fundamental equipment requirements necessary for inclusion in a semi-automatic pipe fabrication system. Utilizing the fundamental equipment requirement as a base we proceeded to investigate the design capability of existing equipment manufacturers. During this investigation, we determined that the equipment required would be listed in the three following categories:

1. Existing
2. Existing, requiring modifications
3. Non-existing requiring the design and manufacture of a prototype.

Upon conclusion of the feasibility study, we entered into a contract with the Maritime Administration.

The primary objective is to design and install a cost effective and semi-automated method of fabricating pipe which will reduce the labor, material handling, storage space and required fabrication area.

Such a facility for the shipbuilding industry must be designed to handle 2" through 24" diameter pipe and all ASTM class and ML SPEC, and schedules and alloys of pipe used in shipboard systems. The facility must be versatile and equipped to handle repair jobs and specialty items, as well as new vessel piping systems.

The following functions represent a pipe fabrication system which can be implemented along with certified procedures where necessary, either in part or as an entire system at any major shipyard.

A. A systematic rack storage and locator system for all types of pipe, in sizes for 2" through 24" must be established. The storage racks must provide for loading, selecting and off loading onto a transfer system automatically.

B. A sorting and automatic feed system must be installed at the pipe storage rack so that an operator can automatically select pipe from the rack, load it onto a conveying system and convey it to the work station.

C. The automatic conveying system for movement of pipe from one work station to another, must be equipped with an automatic unloading device at each station, and a reserve area to hold pipe for each machine.

D. A measuring system must be installed to automatically measure pipe for cutting to length, locating holes and other layout requirements.

E. A system must be furnished to mark each component of the assembly with specific part numbers as identified on the production drawing.

F. Cutting and end preparation machines must be provided. This function is extremely important since, in order to obtain good welding results, the use of machine cutting is an absolute necessity. At this point, all scrap must be conveyed out of the shop area by means of conveyors or other handling equipment.

G. An automatic flange fitting and welding device must be installed and have the capability of processing the pipe alloy mix as well as selecting the flange, orienting it properly, tacking it and welding both inside and out.

H. Adequate numerically controlled bending equipment must be provided capable of two diameter bending for up to schedule 80 pipe 10 inches in diameter. Adequate bending facilities for larger pipe will depend on the number of ship systems for which larger pipe is required. It can be either hot bending or vibratory bending. An important function of this bending equipment in addition to the two diameter bending of pipe up to 10 inches in diameter is the capability of being automatically fed and bent with flanges installed on both ends.

I. Various types of welding equipment must be selected which will be required to process the mix of pipe through the system. Rolling devices must be provided for the welding of straight pipe and these should incorporate automatic loading and unloading mechanisms as well. The development of semi-automatic welding devices for sub assembly areas is desirable along with certified welding procedures.

J. Assembly areas must be equipped with manipulator fixtures designed so that assembly of pipe sections can be processed in an effective manner. Manipulators are to be fitted with semi-automatic loading and unloading devices, and must be capable of positioning the main body of pipe into position so that fitting and welding can be accomplished. The welding devices should be selected and developed concurrently with the manipulator fixtures for this function.

K. The configuration and quantity of x-ray booths and equipment required to support the maximum work load of this work station and provide handling equipment required for loading, manipulating and unloading the x-ray booths must be determined.

L. A semi-automatic internal and external blasting and coating system for pipe must be provided. A bypass would be included so that all full length pipe which does not require further processing would be channeled directly to the assembly area.

M. A specialty area for fabrication of the "inevitable" exception must be designated. Machines, tools and handling equipment must be selected for processing specialty items of a configuration and volume not suitable for automatic and semi-automatic processing. This specialty area would be accomplished by hand.

**N. A final product storage system must be provided where the fabricated pipe and specialty items can be palletized and stored in a racking system in usage order, until required. A locator system to be used for accountability and retrieval, should control the storage function.**

**O. Transportation and handling equipment must be provided for selection load-out and delivery of fabricated pipe to the installation site.**

**P. The computer software package must be developed to support this fabrication shop. Our investigation has revealed that all manhour savings to be experienced by an automatic system can be completely offset by a major increase in the engineering staff necessary to provide the drawing and other data in a timely manner.**

**The cost to implement a system as described would require a capital investment of two to five million dollars dependent upon the existing shop facilities and the size, type and volume of the pipe to be processed.**

**With an investment of this magnitude, management can expect at least 2 things: (1) a return on their investment of approximately 35% per year depending on the facility; and (2) an extremely efficient pipe fabrication shop capable of meeting required production schedules. The system contemplated is designed to produce 150 pipe spools per day, with corresponding limited reduction of skilled shop manpower.**

**The facility is presently under construction. We have completed the building extension and raised the floor 6 inches. The automatic racking system, internal/external cleaning and painting systems and the cutting station are scheduled to be installed and operating by late November, 1979. The balance of the equipment is scheduled for installation and checkout by the end of the fourth quarter, 1980.**

**The majority of the equipment will be originating from Europe coordinated through Oxytechnick of Germany which has been selected as our primary subcontractor responsible for system integration. The N. C. bending machines are supplied by Conrac.**

**When the facility is completed, it will be the most advanced semi-automatic pipe handling and fabricating facility in the world.**



## The Avondale Pipe Shop - Software Status

H. F. Arnold, Vice President -  
Data Processing Avondale Shipyards, Inc.

The semi-automated pipe shop facility, as mentioned, has been designed to produce 150 pipe spools per day. This increase in production brings with it a similar, but harder to achieve increase in the daily pipe spool drawing output. In order to keep all the equipment in the pipe shop optimized, it becomes necessary to have a backlog of approximately 300 pipe spool drawings.

Since the existing manual procedures for drawing pipe details could not maintain this backlog, it became necessary to develop an accurate, cost efficient system for the development of pipe detail drawings.

An intense study was conducted in 1977 to determine the best way in which this system could be implemented. The study compared the benefits and limitations of an expanded manual process versus a number of computer assisted approaches. Since the benefits of an automated design far exceeded a manual procedure, we had to decide which automated system best met the needs of Avondale Shipyards.

The system selected by Avondale was CADAM, the computer augmented design and manufacturing system written by Lockheed.

This system was selected based on:

- 1) The ease with which CADAM could be modified to meet Avondale's pipe drawing requirements.
- 2) The high function of CADAM which allows for expansion of the graphics system into areas other than piping.
- 3) The ease with which CADAM could be interfaced to our existing systems and data bases.
- 4) The ability of CADAM to run on the computer equipment already installed at Avondale.
- 5) The willingness of Lockheed Corp. to work with us in the overall development of the piping systems and necessary interfaces.

Once the selection of the system was made, we worked very closely with Lockheed in the definition of the project. There were a total of 16 enhancements to the basic CADAM software that we identified at that time as being necessary in the piping system. These enhancements included:

- Full three dimensional capability
- Full rotation of any displayed item
- The ability to retrieve from a data base and graphically display the symbol for the various pipe fittings needed in a vessel. (Flanges, Valves, etc)
- The ability to add a drawing to the screen by simply indicating a piecemark number.
- The ability to automatically calculate the cut length of pipe and include set back dimensions of pipe in a socket weld or slip on fitting.
- The ability to automatically calculate bends and the angle of two bends in different planes on the same pipe.
- The ability to add a known point by location from the nearest point of reference. (Frames, Water Lines, Etc.)

Work began on these enhancements in the spring of 1978 and by December, 1978, a demonstration of a basic piping system was made. At this point, we were in a position to refine the enhancement requirements and add one or two functional improvements.

One key element in the development of this piping system came in the form of a parts catalog which is a complete file of the geometric and functional information for approximately 10,000 standard pipe fittings, 2" and above, used at Avondale. This catalog, which was developed by Avondale, was designed for easy interface to the enhanced CADAM system and resulted in a simplified piecemark numbering system for the yard.

With this catalog, the piping engineer can page through the catalog index, select the appropriate piecemark and have it displayed on his graphics device at whatever coordinates he selects. This procedure is repeated until all the piecemarks are selected and displayed and the pipe drawing is complete.

At that time, or whenever it is necessary to plot the pipe drawing, the catalog will supply all the pertinent information for each piecemark identified. This can include any special information needed by the pipe shop in the fabrication of that pipe spool such as special weld considerations or critical dimension data.

The combination of this parts catalog and CADAM with its modifications is estimated to increase our pipe detail drawing productivity by no less than 5 to 1.

Another feature designed into the Avondale pipe spool drawing system is a table of limitations for the equipment in the pipe shop. Every completed PD will be edited against this table to determine if the PD can, in fact, be fabricated in our facility. Those drawings that fail the edit will be flagged for correction by the engineer who created it thereby eliminating the possibility that a pipe spool can begin through the pipe shop and then be scrapped because it is impossible to produce.

The link that ties the pipe spool drawing function to the semi-automatic pipe shop is the scheduling/routing system that is now in its design stage.

This system will take all of the PD'S that are completed and released, prioritize them based on the elements of the specific job, analyze the functions needed to be performed in the pipe shop, determine the specific machines needed to fabricate each PD, schedule the PD'S, route them through the pipe shop to optimize the equipment and generate a two-weeks workload for the pipe shop complete with a list of materials required at each location throughout the shop.

Other considerations in this scheduling/routing system are the inventories of pipe and fittings, and the on order status of pipe and fittings, the equipment maintenance schedules, equipment outage information, alternate routing data, manpower scheduling data and work in process information.

With this system we have bridged the gap between engineering and manufacturing with significant productivity gains.

We expect to have all the enhancements to CADAM completed and in production by the end of 1979. We also expect to have the scheduling software in place by the time the semi-automated pipe shop is in production. At that time we anticipate using the CADAM system for other engineering and production requirements.

Additional copies of this report can be obtained from the  
National Shipbuilding Research and Documentation Center:

**<http://www.nsnet.com/docctr/>**

Documentation Center  
The University of Michigan  
Transportation Research Institute  
Marine Systems Division  
2901 Baxter Road  
Ann Arbor, MI 48109-2150

Phone: 734-763-2465  
Fax: 734-763-4862  
E-mail: [Doc.Center@umich.edu](mailto:Doc.Center@umich.edu)